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Field Report

Impact of Water Temperature on Growth in Cobia, *Rachycentron canadum*, Cultured in Cages

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Abstract

Temperature is a major factor affecting fish growth in natural environments. The relationship between water temperature and growth rate in cobia, *Rachycentron canadum*, was examined at a fish farm in Penghu, Taiwan. Six cages, stocked with 300 fish each, were used in the year-long experiment. Growth rate was monitored by sampling 30 fish from each cage every month. Water quality was optimum throughout the experiment. Fish were fed commercial fish food to satiation twice a day. Cobia grew 0.84%/day in summer (March-September) and 0.41%/day in winter (October-February). The slowest growth occurred in late December at temperatures of 15.0-16.5°C and the fastest during summer at temperatures above 28°C.

Introduction

Growth rate is one of the most important parameters determining economic efficiency in commercial fish culture. Growth patterns in fish vary with time and are influenced by biotic and abiotic factors. Water temperature is among the abiotic factors that affect the quality of culture environments because of its pervasive effects on life history characteristics of fish. Changes in environmental conditions of aquatic communities (e.g., temperature, light, salinity, oxygen availability, water velocity) primarily affect food availability and thus influence growth (Yu and Ueng, 2005). Temperature, in addition, affects the physiology and choice of habitat in fish (Smith and Li, 1983).

Temperature is one of the most important

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environmental factors affecting fish growth (Agawin et al., 1998; Kelly and Arnold, 1999; Graynoth and Taylor, 2000). It can affect growth rates by changing metabolic rates. An increase in temperature can cause an increase in the respiratory metabolism of fish and there are increased maintenance requirements and more rapid loss of weight during starvation (Brett, 1979). Increases in temperature can increase the activity of fish, leading to increased food intake, increased digestion rate, and a change in the efficiency of conversion of food into fish (Brett, 1979).

Cobia (*Rachycentron canadum*) has been studied in different regions of the United States (Briggs, 1960; Smith, 1995; Lotz et al., 1996; Meyer and Franks, 1996; Franks et al., 1999). Most of the research on cobia involved distribution of fish (Franks et al., 1999), reproductive biology (Smith, 1995; Lotz et al.,1996; Meyer and Franks, 1996), recreational fisheries (Richards, 1967; Jones, 1985), and nutrition (Chou et al., 2001, 2004). Few studies evaluated environmental requirements of this species. Denson et al. (2003) suggested that juvenile cobia require moderate to high salinity for sustained growth and health.

Recently, there has been increased interest in the use of thermal effluents to promote fish growth. An obvious implication is that optimum temperatures could increase the growth rate of potential culture species, and save time and money as well.

Taiwan has developed a marine cage culture industry of cobia, *Rachycentron canadum* (Su et al., 2000). The species is of significant economic importance in the Penghu Islands of western Taiwan where fishermen are extremely interested in identifying fish with fast growth rates and low mortality. However, little is known about the effects of water temperature on growth and survival of cobia. This study was designed to examine the relationship between growth rate and water temperature of cobia.

Materials and Methods

Area description. The Penghu consists of 64 islands of various sizes with a total area of 127 km^2. Some 44 are uninhabited. The Penghu Islands, also known as the Pescadores, are located in the middle of the Taiwan Strait, about 40 km from Taiwan, from 23°9'N to 23°45'N and from 119°18'E to 119°42'E (Fig. 1).

The climate in the region is greatly influenced by strong northeastern winds (over 20 m/sec) from November to March. The rainy season extends from May to August, and 80% of the annual rainfall falls during those months. Annual precipitation is 1 m.

The economy of Penghu is heavily dependent on its marine resources. Marine cage aquaculture in inshore and offshore waters has emerged as one of the most important economic activities in Penghu (Taiwan Tourism Bureau, 1991). Development of cage culture began over twenty years ago. Cage culture systems have been used for research, growout of aquatic animals, and short-term holding of fishes (Beveridge, 1987). Most cages are located in inshore waters because of the strong northeastern winds (Chiang et

Fig. 1. The Penghu (Pescadores) Islands, Taiwan.

al., 1995).

Methods. Growth data were obtained from one commercial marine cage farm in western Penghu. Fish (initial weight 700-900 g) were individually weighed and 300 fish were randomly stocked into each of six cages (6 x 6 x 4 m) on November 1, 2004. Fish were fed commercial fish food to satiation twice a day at 8:00 and 15:00. The pelleted feed had 45% crude protein and 14% crude lipid. The surface water temperature was measured daily with a thermometer to 0.1°C. Growth was estimated by monthly sampling of 30 fish from each cage. The experiment terminated on November 1, 2005. Specific growth rate (SGR) was calculated as SGR = $(\log_e W_2 - \log_e W_1)/(t_2-t_1)$, where W_2 = wet weight at t_2 days and W_1 = wet weight at day t_1 (Brett, 1979). Pearson correlation analysis was used to examine the relationship between water temperature and SGR.

Results and Discussion

The cobia were cultured for one year during which the surface water temperature averaged 23.9°C (range 15.0-30.5°C). Average fish weight and temperatures are presented in Fig. 2. Growth rates varied considerably with water temperature, reaching the highest values at 28.6-30.5°C (Fig. 3). Cobia grew at 0.84%/day from March to September and 0.41%/day from October to February, i.e., twice as fast in summer as in winter. The slowest growth occurred in late December at

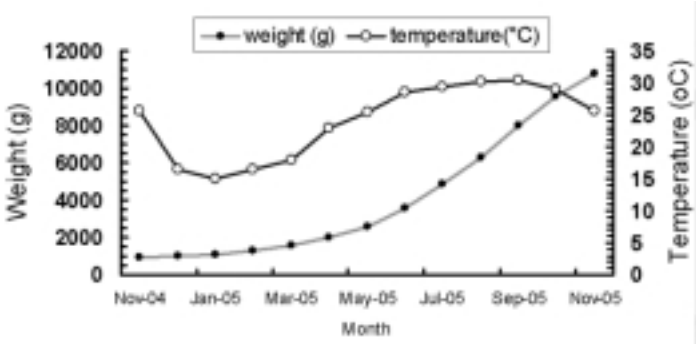

Fig. 2. Monthly fish weight in relation to water temperature.

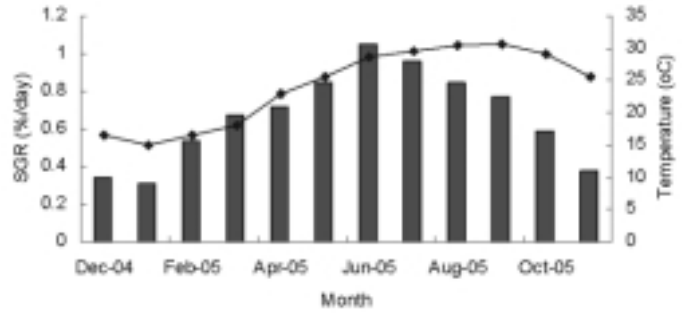

Fig. 3. Monthly specific growth rate (bars) in relation to water temperature (line).

15.0-16.5°C whereas the fastest growth occurred at temperatures above 28°C. A similar relationship of water temperature to growth rate has been suggested for most warmwater fish.

Pearson correlation coefficients of 0.72 implied that only half of the growth rate variation was due to temperature variation. Other factors in its variant environment, such as food availability, may have influenced the cobia growth. Temperature and food consumption rates are the major influences on fish growth (Brett, 1979). A correlation between water temperature and growth rate of cobia showed that an increase of temperature caused an increase of food ingestion. However, too little is known about the effects of different rations of food on cobia growth, and studies are needed to examine the effects of different rations over a range of temperatures.

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